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Analysis of Factors Affecting Food Security in Tapal Kuda Region, East Java, Indonesia

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Abstract. One of the biggest issues facing countries around the world, including the Tapal Kuda region, is food security. Due to the large and productive agricultural area, a variety of food crops, including vegetables, corn, and rice, can be produced. However, it has food insecurity that can be caused by a decrease in crop area, lack of irrigation, low technology, social and economic changes. The purpose of this study is to ensure that poverty levels, rice production, GDP (Gross Regional Domestic Product), and rice prices have an impact on food security in Tapal Kuda. The sampling method used in the study was used deliberately, namely the purposive method. The selected examples are seven districts in the Tapal Kuda region including Probolinggo, Pasuruan, Lumajang, Jember, Bondowoso, Situbondo and Banyuwangi Regencies. Panel data regression analysis is a technique used that involves panel data or variations of cross section data and time series data. The analysis was carried out by managing the data using the Eviews software. The findings of the study show that poverty and rice prices have a negative impact on food security in the Tapal Kuda region, GDP (Gross Regional Domestic Product) and rice production have a positive impact. Optimizing the government's commitment to developing programs based on increasing local food production to keep pace with population growth and ensuring public access to safe and quality food can increase food security.

Keywords: food security; data panel regression; GDP; poverty; rice production; rice prices; tapal kuda; East Java

INTRODUCTION

According to Government Regulation Number 17 (2015), food security is the condition of food fulfillment for the state and individuals, which is reflected in the availability of sufficient food, both in quantity and quality, safe, diverse, nutritious, equitable, and affordable and not contrary to the religion, beliefs and culture of the community, to be able to live healthy, active, and productive lives sustainably. Food security includes aspects such as availability, accessibility, sustainability and food safety. One of the challenges in food security is caused by climate change *El Nino* and when *El Nino* will cause a long-term and very dry dry season and the rainy season will experience a slow down. The production of food crops like rice and corn is impacted by El Nino, which may result in a decrease in it (Malau et al., 2023). In 2022, there will be an increase in the number of hunger or food shortages of around 691 to 783 million people in the world compared to before the pandemic (FAO, 2023). This shows that food security is still a serious challenge globally, especially in regions that have economically vulnerable characteristics. One such area is Tapal Kuda in East Java, which despite being known as an area with great agricultural potential, still faces various obstacles in ensuring food security for all its residents.

The Tapal Kuda is a region situated at the easternmost part of Java Island, often referred to as Java's Eastern Salient.. This region encompasses seven districts: Banyuwangi, Bondowoso, Jember, Lumajang, Pasuruan, Situbondo, and Probolinggo (Satrio and Suyanto, 2020). The Tapal Kuda is located in a strategic area and has great agricultural potential. Known for its fertile soil and supportive climatic conditions, this region is the center of production of various agricultural commodities, especially rice commodities. However, it has food insecurity that can be caused by a decrease in crop area, lack of irrigation, low climate technology and accessibility to food and social and economic changes. Population growth, urbanization, and changing consumption patterns can increase

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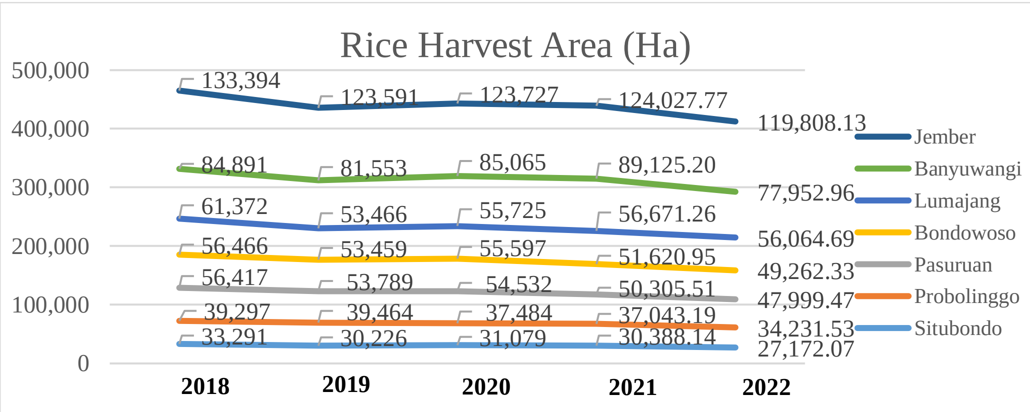
food demand. Meanwhile, accessibility may be impacted by shifts in the region's economic structure and poverty levels. and limitations of food consumption (Zakiah, 2016).

The main problems in food security in the Tapal Kuda are the area of agricultural land, food availability and economic factors. The declining area of agricultural land is due to the transfer of land use in the construction of community houses which occurs due to the increase in the number of population. An adequate area of agricultural land can allow the fulfillment of food commodity productivity properly. If the area of agricultural land decreases, then food stability is threatened, namely the decrease in production produced. Agricultural production is the main source for the people of the Tapal Kuda. Efficient and sustainable agricultural production is essential to meet food needs and availability. Fulfilling food needs will increase regional food security, but to achieve optimal food security, support from various other aspects such as good market access, adequate infrastructure, education and public awareness about nutrition, and supportive government policies are also needed (Sutrisno, 2022). All of these elements need to operate in harmony to guarantee adequate food supply, fair distribution, and proper food use, ensuring long-term food security in the Tapal Kuda region.

Table 1. Rice Harvest Area



Source: Central Bureau of Statistics, 2022

Rice is a rice-producing food crop that makes a great contribution to meeting the community's carbohydrate and energy needs. Sufficient rice stocks are considered an indicator of food security, but the price of rice can affect people's purchasing power. The government maintains rice reserves as part of the food security policy to anticipate crop failures and maintain stability in rice prices. The production and availability of rice and rice prices in the Tapal Kuda area are very important to maintain food security and meet the food needs of the local population. Based on Table 1. shows data on the area of rice harvest in the Tapal Kuda area in 2018-2022 which has experienced relatively declining fluctuations. The average percentage decline in the Tapal Kuda area in 2018-2022 was 3.1%. The decline in harvest land has the potential to disrupt the availability of enough food to meet the needs of the community as a whole. When food production capacity declines, the government's ability to ensure an adequate and equitable food supply is threatened.

National food security is assessed using the Food Security Index (IKP) which shows a status from very resistant to non-resistant. The scores of the food security index and stunting prevalence in the Tapal Kuda area in 2023 are presented in Table 2. However, areas that are categorized as resistant do not necessarily have a good public health status. This is related to the high average prevalence of nutrition and health problems in the Tapal Kuda area, especially stunting in early childhood. The high prevalence of stunting occurs due to policies that focus too much on controlling the quantity of production without paying attention

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to nutritional quality (Astuti, 2024). The high prevalence of stunting also occurs in poor families who have limited access to nutritious food. Therefore, an area that shows food security, efforts are still needed to overcome poverty to improve the overall health and nutritional status of the community. The poverty rate in the Tapal Kuda area is relatively high compared to other areas in East Java presented in Table 3. Poverty levels also have an impact on people's ability to buy goods and services, which in turn can reduce the level of demand. The decline in demand indicates that consumers tend to reduce their consumption, which has an impact on decreased productivity and investment. This condition has the potential to hinder economic growth, including a decline in GDP (Nugraha et al., 2024).

Table 2. Food Security Index and Stunting Prevalence Index Score in Tapal Kuda in 2023

Regency	IKP Score	Category Resistance Food	Prevalence Stunting (%)	Category Prevalence Stunting
Lumajang	79,42	Highly Resistant	29,9	Tall
Jember	77,43	Highly Resistant	29,7	Tall
Banyuwangi	84,91	Highly Resistant	21,9	Tall
Bondowoso	75,5	Endure	17,0	Quite tall
Situbondo	76,64	Highly Resistant	4,1	Low
Probolinggo	73,27	Endure	35,4	Very high
Pasuruan	79,87	Highly Resistant	29,9	Tall

Source: Food Security Index and Indonesian Nutrition Status Survey, 2023

Table 3. Poverty Percentage in 2018-2023 in the Tapal Kuda Region

No	Regency/City	2018	2019	2020	2021	2022	2023
1	Lumajang	9,98	9,49	9,83	10,05	9,06	8,93
2	Jember	9,98	9,25	10,09	10,41	9,39	9,51
3	Banyuwangi	7,8	7,52	8,06	8,07	7,51	7,34
4	Bondowoso	14,39	13,33	14,17	14,73	13,47	13,34
5	Situbondo	11,82	11,2	12,22	12,63	11,78	11,9
6	Probolinggo	18,71	17,76	18,61	18,91	17,12	17,19
7	Pasuruan	9,45	8,68	9,26	9,7	8,96	9,24

Source: Central Statistics Agency, 2023

Poverty is closely related to food security in the community. When individuals or families live in poverty, they often face limitations in accessing nutritious and adequate food. The inability to purchase healthy and affordable food, as well as lack of access to agricultural land, agricultural technology, and training, can exacerbate food security conditions in impoverished communities. The high poverty population can also result in balanced malnutrition, because balanced nutritional intake is one of the causes of stunting.

To maintain food security in the Tapal Kuda region in a sustainable manner, an analysis of factors affecting food security in the Tapal Kuda region is needed. The factors analyzed were Gross Regional Domestic Product (GDP), rice production, poverty and rice prices. These factors were chosen because

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they affect the community's access to reliable and sufficient food, particularly with regard to the community's future nutritional state. The results of the analysis obtained can be used as a reference for evaluating food security in the Tapal Kuda and to ensure the community's access, availability, and consumption of wholesome food.

Studies on the analysis of factors affecting food security have been conducted in depth by Wehantow et al., (2024) ; Muttaqin et al., (2022) ; Jihan (2021) ; Abidin et al., (2020) ; Ariesa and Khairan (2019) ; Damayanti and Khoirudin (2016). The novelty of this study lies in the indicators of food security factors specific to the Tapal Kuda region, namely per capita income, Gross Regional Domestic Product (GDP), population, rice harvest area, poverty, rice prices and rice production. In previous research, not many people used these variables and used panel data regression analysis tools and no one had taken research on food security factors in the Tapal Kuda area. This study is also unique because it examines food security using a panel data approach in the Tapal Kuda area, an area with high food vulnerability but has not been analyzed quantitatively. The formulation of the problem raised in this study is "How do the influence of GDP, rice production, poverty, and rice prices on food security in the Tapal Kuda area?"

METHODS

Regional Determination

The determination of the location of this research was carried out in a *Purposive Method* namely Tapal Kuda. The purposive method is the determination of location in a deliberate way (Muhlis et al., 2023). The determination of Tapal Kuda takes into consideration that there are still many problems that threaten food security such as the economic condition of Tapal Kuda which tends to fluctuate, information that shows the Food Security Index score with the stunting prevalence score presented in Table 2 and accompanied by an increase in the number of poor individuals presented in Table 3 and the high dependence on the food agriculture sector, making it a strategic location to study the dynamics of food security.

Research Methods

A quantitative descriptive method is used in the investigation. The Tapal Kuda region's internal and external factors that may impact food security are described using descriptive research techniques, such as climatic factors, infrastructure, and local agricultural practices. Quantitative research is used for the sustainability of descriptive research whose finding the association is the aim between two variables that are interconnected in the form of differences, relationships, or influences (Ali et al., 2022). Through a quantitative approach, empirical data can be statistically analyzed to give a better understanding of the degree to which these variables affect each other (Endra, 2017).

Data Collection

Secondary data is used in data acquisition. Panel data, a type of secondary data, is created by merging time series with cross-sectional data (Alamsyah et al., 2022). The secondary data used was sourced from the National Resilience Agency, East Java's Central Statistics Agency, Tapal Kuda's Central Statistics Agency of Regencies, the Agriculture and Food Security Service in the Tapal Kuda and other supporting data (previous research and related agencies). The study's secondary data were variable data which is studied including gross regional domestic product (GDP) data, rice production, poverty and rice prices in the Tapal Kuda.

Data Analysis

Panel regression analysis refers to a method that utilizes panel data, this integrates time series and cross-sectional data. Analysis of regression using panel data enables more thorough and diverse information to be obtained and result in a low level of collarity between variables (Nwakuya and Ijomah, 2017). Panel data regression analysis was chosen because it allows it to capture the dynamics of changes and variations between units more accurately and efficiently. This method also helps to control unobserved heterogeneity and reduce the problem of

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multicollinearity, making the results of the analysis more valid and reliable.

The data used were time series data from 2018-2023 and cross section data for seven Tapal Kuda areas (Jember, Bondowoso, Situboondo, Probolinggo, Banyuwangi, Lumajang and Pasuruan Regencies). Eviews software was used to manage the information to do the analysis. The use of Eviews software can process data efficiently (Friera et al., 2024). In order to ascertain the impact of poverty, rice output, GDP, and rice prices on food security, this study employed regression analysis on panel data in the Tapal Kuda. The estimating model used in this study described in Equation 1.

Yit = β0 + β1X1it + β2X2it + β3X3it + β4X4it + eit...(1)

Information:

Yit = Food Security Index; β0 = Constant; β1 β1 β1 β1 β1 β1 = Coefficient of Independent Variables; X1it = GDP (Rp); X2it = Rice production (Ton); X3it = Poverty (%); X4it = Rice Price (Rp); eit = *Error*

Three methods are used when selecting the panel model to test the equation: the models of fixed effects, common effects, and random effects. Proper choosing a model, regression analysis of panel data can produce more accurate and efficient parameter estimation. The most straightforward method for estimating Common Effect is the panel data model parameters. This method integrates cross-sectional and time series data as a single unit, disregarding time and individual differences, and utilizes Ordinary Least Squares (OLS) for analysis. The common effects model in this study is described in Equation 2.

Yit = β0 + β1X1it + β2X2it + β3X3it + β4X4it + eit...(2)

A fixed effects panel model is one that features a unique intercept for each subject (cross section) but has a constant slope between the subjects. One drawback of the fixed effect approach is that it reduces the degree of freedom, which lowers parameter efficiency. The fixed effect model model in this study is described in Equation 3.

Yit = (β0it + β0i + β0t) + β1X1it + B2X2it + B3X3it + B4X4it + eit..........................(3)

According to the random effect concept, the variations between units are random and come from a certain probability distribution. Random effects treat intercepts as different random variables for each unit. The random effect model model in this study is described in Equation 4.

Yit = (β0it + β0i + β0t) + β1X1it + B2X2it + B3X3it + B4X4it + (μi + eit).................(4)

The Chow, Hausman, and Langrange multiplier tests were used to evaluate which of the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM) was the best estimating model.

Using the Chow test, the optimum model between the Common Effect Model and the Fixed Effect Model is determined (Hidayat et al., 2018). Eviews software is used to perform this test, and under Cross-Section Chi-Square, the findings are shown in the Prob column.

Chow Test Hypothesis:
H0: The CEMis the selected model;
H1: The FEM is the selected model.

If the probability value (P-value) of the cross-section is F>0.05 (significant value), the CEM is the best model. which means that H0 is acceptable. However, H0 is rejected if the cross-section's probability value (P-value) is F<0.05 (significant value), suggesting that the Fixed Effect Model is the superior choice. If a fixed effect model is selected, more testing is required to ascertain if the model is a fixed effect or a random effect.

The Hausman test is used to determine which of the Fixed Effect and Random Effect models to use. Results of testing with Eviews are displayed in the Prob column values . *Cross-Section Random*.

Hausman Test Hypothesis:
H0 : The REM is the selected model.
H1 : The FEM is the selected model

H0 is approved if the Random Effect Model (REM) is the best model and the probability value (P-value) of the random cross-section is more than 0.05 (a significant value). If the probability value (P-value) of the random cross-section is less than 0.05, a

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significant value, and H0 is rejected, the Fixed Effect Model is the better option. Choosing the right model will affect the accuracy of the estimation and interpretation of the analysis results, while choosing the wrong model can lead to improper conclusions regarding the relationships between variables in the panel data**.** An advanced test (LM test) is required, if the random effect model is used to do the Hausman test.

The Random Effect Model's and the Common Effect Model's relative strengths are assessed using the LM test. Breusch-Pagan's Random Effect Model is used to determine significance based on the OLS method's residual values. EViews is used to conduct the test, and the outcomes are available in the Breusch-Pagan Cross-Section column of the output.

LM Test Hypothesis:
H0 : The CEM is the selected model.
H1 : The REM is the selected model.

If the Breusch-Pagan cross-section value is higher than 0.05 (a significant value), the Common Effect Model is chosen, which indicates that H0 is accepted. The Random Effect Model is used if the Breusch-Pagan the cross-sectional value is below 0.05., which is considered a significant value.

Classical Assumption Test

The classic assumption test in panel data regression analysis is used to ensure that the regression model meets the criteria of the Best Linear Unbiased Estimator (BLUE) or the model provides the most efficient and unbiased estimation results in linear form, so that the estimation results are valid and reliable. This test includes checks for multicollinearity, heteroscedasticity, normality, and autocorrelation. The classic assumption test also serves to avoid misinterpretations of the analysis results and increase confidence in the model used in the regression of panel data.

1. The Normalcy Test

As stated by Purnomo (2016), to ascertain the normality of the autonomous and dependent variables in the regression model, the normality test is performed.. One approach to evaluating residual normality is the Jarque-Bera (JB) test, a statistical method used to ascertain whether the information follows a normal distribution. This test measures the deviation from normality by calculating the skewness and curtosis of the data distribution. To ascertain whether the data has a normal distribution, the test's results are utilized.

Normality Test Hypothesis:
H0 : Data that is routinely distributed
H1 : The distribution of the data is abnormal.

A normal distribution is assumed for the data if the probability ≥ 0.05 and the Jarque-Bera (J-B) value ≤ X2 of the table. It is determined that the data does not have a distribution that is normal if the likelihood value is less than 0.05 and the value Jarque-Bera (J-B) ≥ X2 table.

2. Multicoliality Test

A statistical technique for identifying significant correlations the multicollinearity test examines Two or more independent variables and their relationship. There should be very little multicollinearity in a trustworthy regression model, when the free variables in the model should exhibit no correlation among independent variables or be free from multicollinearity (Ghozali, 2018) . The following are the criteria for regression models that do not have multicollinearity:

a. VIF (*Variance Inflation Factor*) value < 10
b. Tolerance value > 0.10
c. Correlation Rate Value < 95%

3. Heterokedasticity Test

Finding out if there are variations in residual variance between the data in the regression model, Test of Heteroscedasticity is performed, the Glejser test is used on the condition that if the probability of significance is above 5% or 0.05, then there is no heterokedasticity.

Heterokedasticity test hypothesis:
H0 : No heterokedasticity
H1 : There is heterokedasticity

H0 is authorized in the event when its p-value is below 0.05., indicating that the model does not have a heterokedasticity issue; if the p-value falls below 0.05, the model does have a heterokedasticity issue.

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4. The test for autocorrelation

To ascertain whether the error term in period t and the error term in period t-1 are related, the autocorrelation test is used. This test helps identify whether errors in consecutive periods are related. Significant autocorrelation detection can indicate the presence of patterns in unmaintained residuals, which can affect the validity of the regression model and result in inefficient parameter estimation. A good regression model should not be autocorrelated which can be tested using *the Woolridge Test Autocorrelation*.

Autocorrelation Test Hypothesis:
H0 : No autocorrelation
H1 : There is an autocorrelation

Autocorrelation is present if the P-value, or probability value, is below 0.05. However, if the P-value exceeds 0.05, autocorrelation does not exist.

Hypothesis Testing

1. Partial Test

To determine whether the independent variables alone significantly affect the dependent variable. The regression coefficient's significance test (t-test) is used. Each independent variable's unique contribution to the explanation of fluctuations in the dependent variable is ascertained with the aid of this statistical t-test. Comparing the t-value that was computed to the crucial t-value from the table is how the t-test is carried out.

Test Hypothesis:
H0 : $\beta i = 0$ (There is some reciprocal influence between the independent and dependent variables)
H1 : $\beta i \neq 0$ (The independent and dependent variables don't fully correlate with one another)

H0 is accepted if the p-value is more than 0.05 and the t-value is less than the t-table value, suggesting that one of the independent variables has no appreciable effect on the dependent variable. As demonstrated by the t-count > t-table and the p-value < 0.05, H1 is accepted if one of the independent factors significantly (at a 5% significance rate) affects the bound variable.

2. Model Feasibility Test (Test F)

The F test is used to determine how well each independent variable can explain the dependent variable when considered collectively. The study's goal is to determine whether each independent variable put together has a meaningful effect on the dependent variable. To conduct this test, the F-value is compared with the F-table value at a significance level < 0.05. A significant F test result indicates that at least one independent variable explains the dependent variable in a meaningful way.

Test Criteria F:

a. If the p-value of the F-statistic is less than 0.05 and Fcal is bigger than F-table, then H0 is rejected, suggesting that the independent factors together have an impact on the dependent variables.
b. H0 is accepted, indicating that the independent elements taken together have no effect on the dependent variables, if the p-value of the F-statistic > 0.05 and Fcal < Ftable.

3. R^2 Determination Coefficient Test

The degree to which the model can explain dependent variables is determined using the determination coefficient (R^2) test. Cross section data have a relatively low determination coefficient value due to large variations between different observations, while time *series* data tend to have a relatively high determination coefficient value. A high R^2 score indicates that the model can adequately explain the dependent variables. The coefficient of determination has a value of 0 ($< R^2 < 1$) between 0 and 1. When the value is close to 1, the independent variable accounts for most of the variance in the dependent variable. The ability of the independent variables to explain the variance in the dependent variable is limited by a low R^2 value.

RESULTS AND DISCUSSION

To ascertain which panel data regression model best explained the variables influencing food security, tests such as the Chow test, Hausman test, and Lagrange multiplier test were employed.

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With a 10% significance threshold, the Chow test determines which is the best of the Fixed Effect and Common Effect models.

Table 4. Chow Test Result

Effect Test	*Statistics*	*p-value*
Cross-section F	12.235690	0.0000

Source : Eviews 9, 2024

The cross-section F's p-value is 0.0000, which indicates that H0 is rejected based on the Chow test results and H1 is accepted. Therefore, the model that was chosen or proven to be the most successful is the fixed effect kind.

To ascertain the optimal fixed effect and random effect model, the Hausman test is employed with a 10% significance level. The Hausman test results are shown as follows:

Table 5. Hausman Test Results

Effect Test	*Chi2 Statistic*	*p-value*
hausman test	32.746860	0.0000

Source : Eviews 9, 2024

The results of the Hausman and Chow tests indicate that the fixed effect model is the most appropriate, hence the Lagrange multiplier test is not performed. Consequently, the analysis of factors influencing food security in the Tapal Kuda region is conducted using a fixed effect model regression analysis of panel data.

The regression of this research panel data was subjected to traditional assumption tests, including multicollinearity tests, heterokedasticity tests and autocorrelation tests. The outcomes of the unbiased regression equation were subjected to the traditional assumption testThe subsequent are the outcomes of the traditional test of assumptions:

To identify multicollinearity problems or deal with the issue of strong correlation between independent variables, the multicollinearity test is utilized. In the event that the VIF value is below 10 and the correlation value across variables is less than 95%, multicollinearity problems can be detected. Table 6 displays the multicollinearity test results (correlation values).

Table 6. Multicollinearity test results (correlation value)

	GDP	**Rice Harvest Area**	**Poverty**	**Rice Prices**
GDP	1.000000			
Rice Production	0.363177	1.000000		
Poverty	-0.536660	-0.566728	1.000000	
Rice Prices	0.240219	0.201912	-0.350057	1.000000

Source : EVIEWS 9 estimation results (processed by researchers)

Table 7. Multicollinearity Results (VIF Value)

Variable	**VIF**
GDP	1.205585
Rice Production	1.735603
Poverty	1.657014
Rice Prices	1.101325

Source : EVIEWS 9 estimation results (processed by researchers)

If the correlation between the independent variables and the VIF value is less than 95% and less than 10, the multicollinearity test findings indicate that the panel data regression model utilized does not exhibit multicollinearity. In addition, a normality test was performed to ascertain the data distribution.

Normality Test

The probability value obtained from the normality test is 0.107972, it suggests that the probability value is more than the α 0.10,

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according to the graph of the results. Typically, the data is scattered, according to the results. It is believed that data with a total value greater than 30 is regularly distributed. To find differences in non-constant residuals, a heteroscedasticity test was also performed.

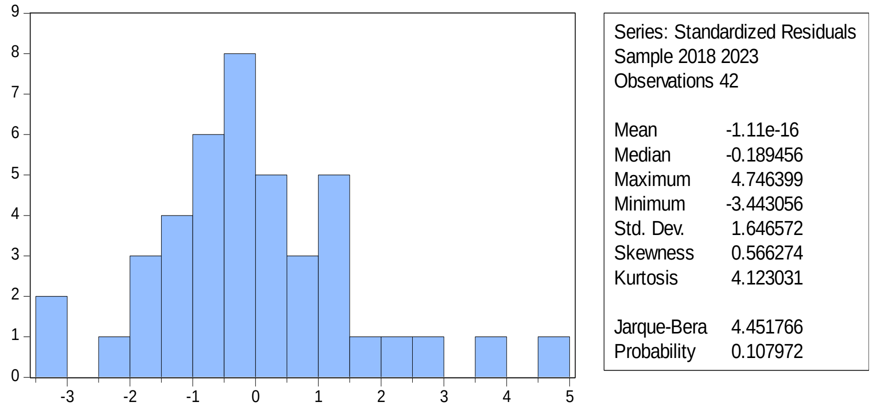

Figure 1. Graph of Normality Test Results

Heteroscedasticity Test

It is evident from the residual graph that it stays below the limit. (500 and –500), meaning that the residual variant is the same. Therefore, heteroskemasticity is not present in the data model that is utilized. The last test is the autocorrelation test.

Autocorrelation Test

The autocorrelation test findings are shown by the Durbin Watson value. A DW value of 2.926155, a dL value of 1.3064, and a dU value of 1.7202, as determined by the autocorrelation test, indicate that there is no autocorrelation because the DW value is greater than the dU.The next stage is to estimate the panel data regression in line with the chosen model after choosing the panel data regression estimation model and performing the classical assumption test to make sure the model is free from classical assumption issues. To determine how independent and dependent variables are related, this procedure involves analyzing regression coefficients. Table 8 explains using the panel regression analysis test as a basis.

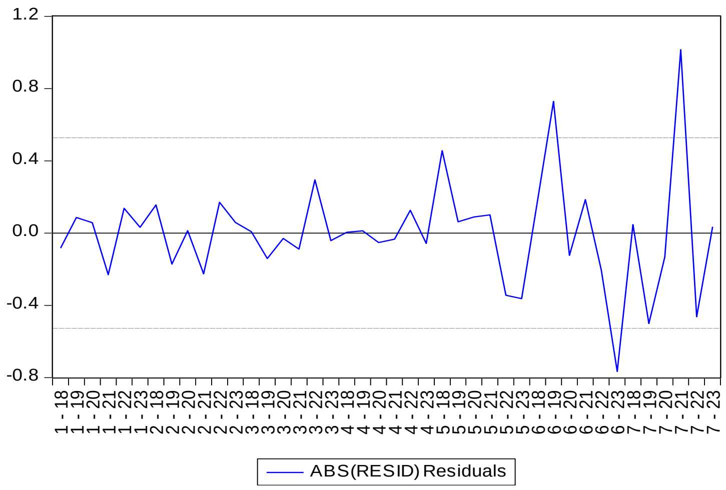

Figure 2. Graph of Heteroscedasticity Test Results

According to the estimation's findings, the variables of GDP and rice production are known to significantly affect the availability of food in the Tapal Kuda at a level of 10% and to have a positive coefficient value, whereas the variables of poverty and rice prices have a

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negative coefficient value and no significant impact. The following model is formed in the panel data regression estimation in Equation 5.

Y = 6.283843 + 0.000212 X1 + 1.62E-05 X2 – 0.116214 X3 – 0.000383 X4 + e...............(5)

With a significance level of 10%, the analysis's findings indicate that, with the value of F-Statistics (19.34) > F-table (2.10), H0 is rejected, indicating that all independent factors (GDP, rice production, poverty and rice price) together affect food security in the Tapal Kuda. The specifications of the model formed are feasible to interpret the influence of GDP (X1), rice production (X2), poverty (X3) and rice price (X4) on food security in the Tapal Kuda (Y) region. According to the 0.817319 revised R-squared value, the variables of GDP (X1), rice production (X2), poverty (X3) and rice price (X4) together affected food security in the Tapal Kuda by 81.73%.

Table 8. Regression Results Based on *the Fixed Effect Model* (FEM)

Variable	coefficient	Std. Err.	t	P>ItI
C	6.283843	1.131932	5.55	0.00
GDP	0.000212	3.95E-05	5.38	0.00*
Rice Production	1.63E-05	8.65E-06	1.88	0.06*
Poverty	-0.116214	0.592089	-0.19	0.84
Rice Prices	-0.000383	0.000678	-0.56	0.57
Number of obs	42			
F-Statistic	19.34350			
R-squared	0.861875			
Adj R-square	0.817319			
Prob(F-statistic)	0.000000			

Source : EVIEWS 9 estimation results (processed by researchers)
Note * = signifikan 90% confidence level

Considering the results of the panel data regression analysis, food security in the Tapal Kuda is significantly impacted by the GDP variable (X1). The probability value of 0.0000, which indicates that the value is smaller than the value of 0.10, indicates this. With a positive coefficient value of 0.000212, the GDP variable indicates that a 1 Rupiah increase in GDP will result in a 0.000212 increase in the Tapal Kuda's food security index. This demonstrates how food security has increased in the Tapal Kuda is influenced by the size of the regional GDP. This is also similar to the study Biantoro (2017) , which states that GDP significantly affects food security in Central Java Province and is in line with research Jihan (2021),in the Eastern part of Indonesia, rising GDP can raise per capita income, which has a major positive impact on food security.

GDP per capita reflects the average income of the population in an area. When GDP increases, people's purchasing power also tends to increase (Khairunnida and Yuni, 2024). This allows individuals to access more nutritious and diverse foods, thereby improving the status of food security in the Tapal Kuda region. The increase in GDP is also accompanied by greater investment in the agricultural sector. These investments can be in the form of improved agricultural infrastructure, technology, and training for farmers, all of which contribute to increasing local food production. The high GDP also reflects the existence of sufficient resources to support food production, such as adequate agricultural land and skilled labor. This availability contributes to the stability of food supply in the local market. GDP, especially in the agricultural sector, which increases in a region can also reduce the level of poverty in that region (Harahap et al., 2022).

The rice production variable (X2) significantly affects the availability of food in the Tapal Kuda area. The likelihood value of 0.0691, this shows that the amount is less than 0.10, supports this. With a coefficient value of

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positive 1.63000005, the rice production variable indicates that a 1 ton increase in rice production will result in a 1.63 increase in the food security index in the Tapal Kuda area. This indicates that the amount of rice produced in the Tapal Kuda area has an impact on the rise in food security. This is also similar to Abidin (2020) research, which claims that rice production has a significant negative influence on food expenditure, because when rice production increases, it can reduce household food consumption. This indicates that a household's level of food security will rise in proportion to its food expenditures.

Increased rice production has significant potential to increase food security. Increasing rice production can ensure more stable food availability, reduce dependence on imports, and reduce food insecurity in times of crisis (Yusri et al., 2021). Increasing rice production can support rice distribution to other regions that need sufficient supplies. In addition, with a surplus of rice production, people in the Tapal Kuda area can enjoy more affordable prices and more easily access basic food needs. It also opens up opportunities to strengthen the local economy through increasing farmers' incomes and developing the food processing industry.

The poverty variable (X3) had no discernible impact on the Tapal Kuda's food security. A probability value of 0.8457, which indicates that the value is higher than 0.10, indicates this. With a negative coefficient value of -0.116214, the poverty variable indicates that a 1% rise in poverty will result in a 0.116214 decrease in the Tapal Kuda's food security index. This is consistent with studies carried out by Wehantouw (2021), It claims that food security is negatively impacted by poverty and research Muttaqin (2022), which states that the more poor households, the lower the food security. An increase in the percentage of poverty can reduce food security, especially through the impact on people's purchasing power. As poverty levels increase, many individuals and families experience limitations in accessing sufficient and nutritious food. This is due to low income which makes them unable to afford quality food, so they are forced to rely on cheap food which is often less nutritious.

Based on the results of the regression analysis, the poverty variable did not show a statistically significant influence on food security in the Tapal Kuda area. This insignificance can be explained through several contextual and structural approaches. In general, the Tapal Kuda area has the characteristics of a community that is still highly dependent on the subsistence agriculture sector and local food sources, where food needs can be met independently without having to rely entirely on purchasing power or cash income. This means that even though households are statistically classified as poor according to income indicators, they can still maintain food security through their own agricultural products, yard land use, or assistance from local social networks. In addition, the presence of various social assistance programs such as Non-Cash Food Assistance (BPNT) and the Family Hope Program (PKH) also helps poor households to continue to have access to food. This causes the poverty level not to directly reflect food security.

The rice price variable (X4) has no real effect on food security in the Tapal Kuda. This is indicated by the value of probability, namely 0.5758 this indicates that the value is higher than 0.10. With a negative coefficient value of -0.000383, the rice price variable indicates that a 1 Rupiah increase in rice prices will reduce the food security index in the Tapal Kuda by 0.000383. This is in accordance with research Zakiah (2016), which states that high rice prices can reduce rice consumption, where rice contributes greatly to energy sources and regional food security.

The results of the analysis also showed that rice prices did not have a statistically significant effect on food security in the Tapal Kuda area. This phenomenon can be explained by considering the food consumption patterns of people in the region which tend to be more diverse and not completely dependent on rice as the main source of carbohydrates. In the condition of rising rice prices, people can still

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replace it with other local food sources such as corn, cassava, sweet potatoes, or their own garden products. This diversification of consumption makes the price of rice not the main determining factor in household food security. In addition, government intervention through food price stabilization and subsidized rice distribution also helps to reduce the impact of price fluctuations on people's food availability and access.

Food security may be compromised by rising rice prices, particularly for those with low incomes. One staple food is rice in Indonesia and plays a significant part in people's eating habits. Malnutrition and long-term health issues may arise as a result of households having to cut back on rice consumption or switch to less nutrient-dense meals due to rising prices. This is in line with research (Santoso et al., 2024) which claims that people's purchasing power for rice may be lowered by rising rice prices. In addition, the high dependence on rice causes many families to find alternative foods that are more affordable but still nutritious. An increase in rice prices can also trigger inflation, which further worsens the food security situation. When rice prices rise, the overall cost of living increases, forcing workers to demand wage increases. The cost of manufacturing other commodities may rise as a result, thus creating an inflationary cycle that is detrimental to people's purchasing power as a whole.

The variables of poverty and rice prices do not have a statistically significant effect on food security in the Tapal Kuda region can be explained in Table 3 and Table 9. The highest average poverty percentage in the Tapal Kuda area in 2018-2023 is Bondowoso Regency with a value of 13%, which means that the area is close to the poverty threshold of 11.37% and the IKP score in the Bondowoso area in 2018-2023 remains in the "Resistant" category. The increase in rice prices shows that the highest percentage increase from 2018 to 2023 is Lumajang Regency with a value of 21.3%, where the IKP score value of the region is in the "Highly Resistant" category. These two variables show that the increase in poverty and rice prices do not directly affect the IKP value category in the region.

Table 9. Rice Prices in the Tapal Kuda Area in 2018-2023 (Rp).

Regency/City	2018	2019	2020	2021	2022	2023
Jember	9333	9500	9500	10166	10000	10900
Bondowoso	10000	9750	9500	9625	9675	9875
Situbondo	9533	9933	10233	10233	10833	9800
Probolinggo	9066	10100	9533	9666	9300	9466
São Paulo	10600	10300	10000	10700	9180	10680
Pasuruan	10033	10250	9666	10000	9700	10266
São Paulo	9066	9166	9000	9333	10000	11000

Source: Central Statistics Agency, 2023

This research cannot be separated from the shortcomings because the researcher has limitations, one of which is the limitation of the number of variables and the number of samples. The number of variables used for the formulation of the problem of factors affecting food security in the Tapal Kuda area includes GDP, rice production, poverty and rice prices. Meanwhile, the number of samples used was seven Tapal Kuda areas (Jember, Bondowoso, Situbondo, Probolinggo, Banyuwangi, Pasuruan, and Lumajang Regencies) with the period of 2018-2023. The researcher considers that the four variables and the number of samples are able to describe three aspects of food security (availability, access and utilization).

CONCLUSION

This study found that GDP and rice production significantly increase food security in the Tapal Kuda region. On the other hand,

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poverty and rice prices do not have a statistically significant effect. The proposed policy implications include strengthening investment in the agricultural sector, increasing local productivity, and optimizing social protection programs that maintain food access for poor households. This study is limited to macro variables, so further studies are recommended to examine the socio-cultural and local infrastructure aspects that affect food security

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